**Jet Propulsion Laboratory**
California Institute of Technology

# Spatial Statistical Data Fusion of AIRS and CrIMSS Near Surface Temperature

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# Goals

Create a near-surface temperature (NST) data set hyperspectral sounder observations

    climate model evaluation

    applications (?)


Fuse AIRS and CrIMSS

    eventually include entire sounder network

    Spatial-Statistical Data Fusion (SSDF, Nguyen et. al., 2012)

        joint kriging with multiple data sets

        exploits spatial covariances within and between input data sets.

        accounts for different footprints, biases, variances of inputs


Reliable uncertainties on input data sets are required.

Peter Kalmus

# Data fusion of AIRS + CrIMSS CHART NST

Eastern US

8 months: [Jan, Apr, Jul, Oct] x [2013, 2015]

Fusion done on a daily basis, separately for day & night, 0.5° output grid

   AIRS v6 IR+MW support product, DQ 0, 1

   CrIMSS CHART IR+MW

1.   Estimate bias and variance of AIRS and CrIMSS data, vs. NOAA ISD "truth"
     a.   Matchup criteria: 45 km, ±30 minutes (ISD is typically every 15 minutes)
     b.   Bias, variance estimates made in 2-degree hexagonal bins, 3-day averages
2.   Perform data fusion with **pySSDF**
3.   Validate fused result

# NOAA ISD
# Integrated Surface Database



Rolls global hourly or sub-hourly ground station data from 100+ sources into single format.

14k active stations globally

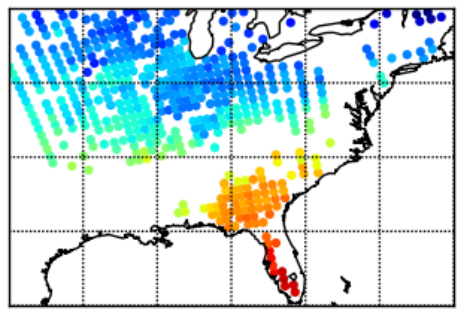   assimilating more data sources, extending record spatially and temporally

https://www.ncdc.noaa.gov/isd

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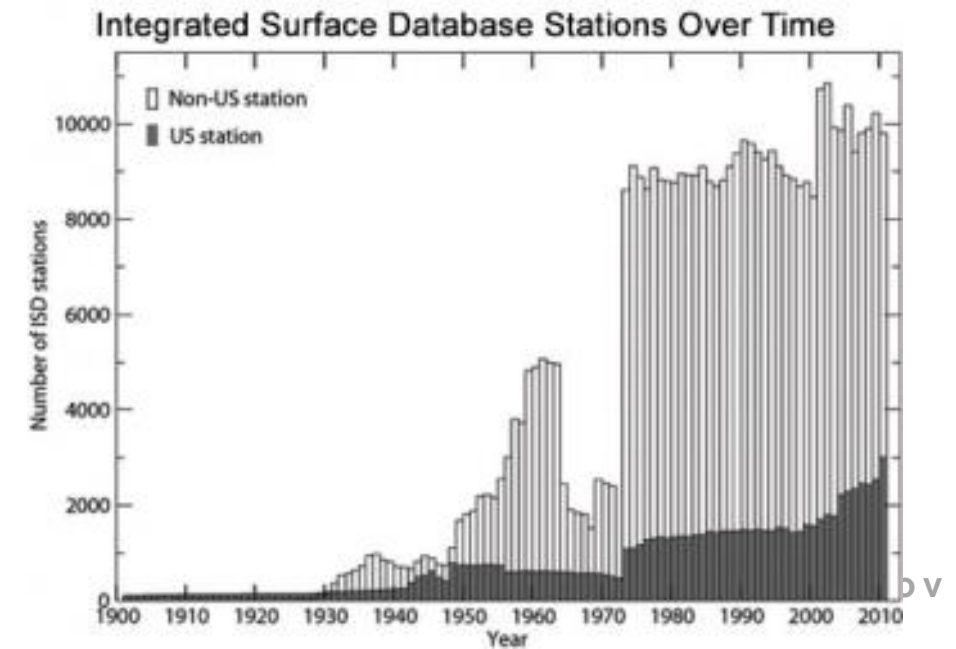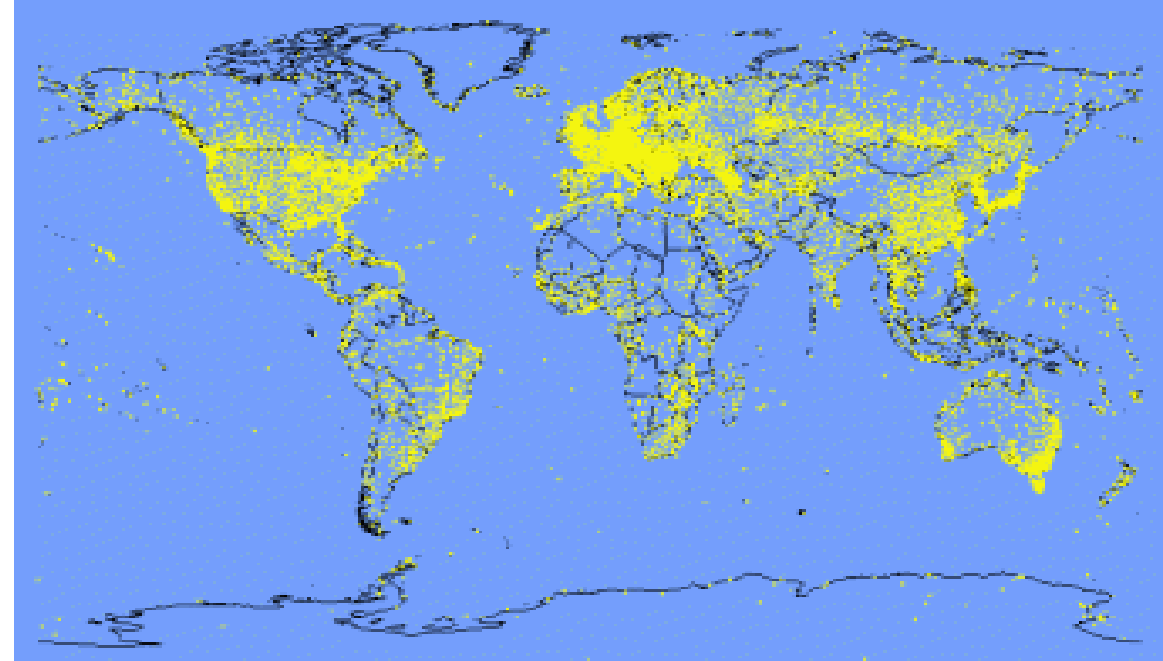
# Sample results

We have experimented with different sets of basis functions

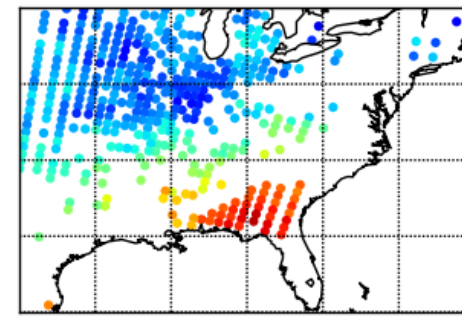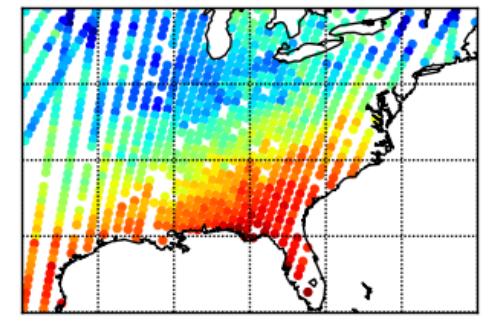~2 hours to fuse all 8 months on one core on `weather`
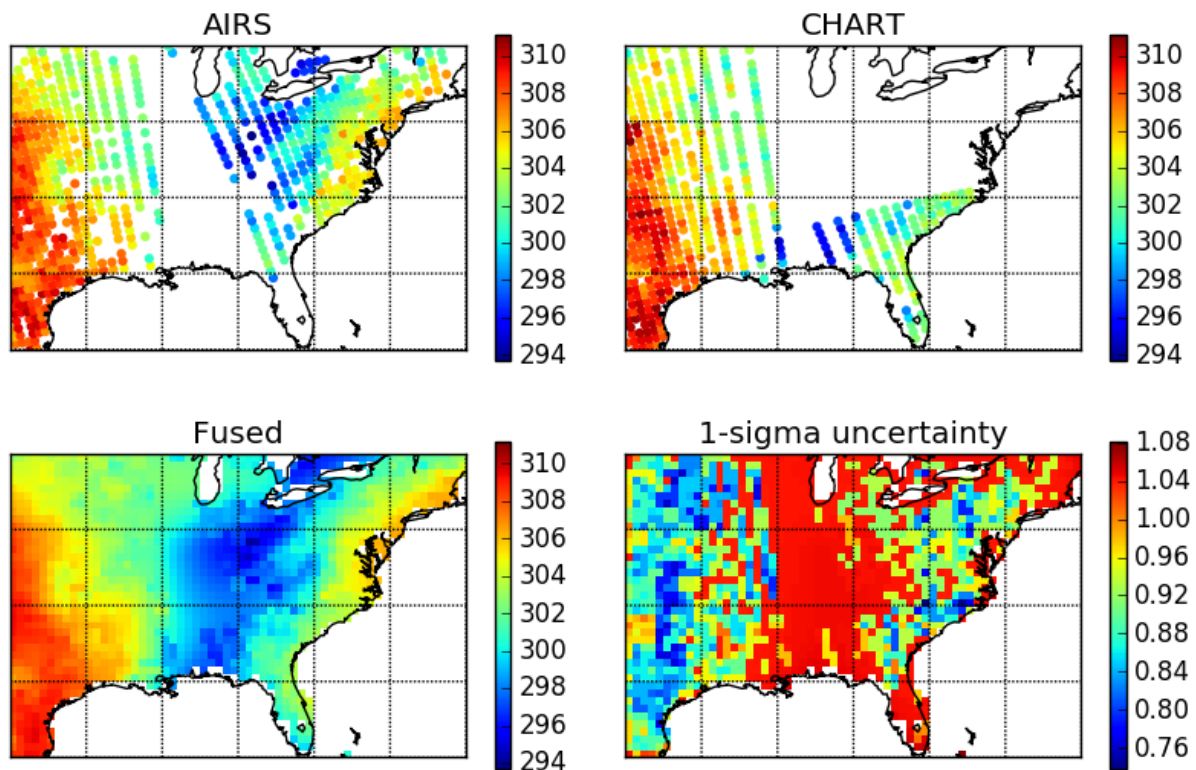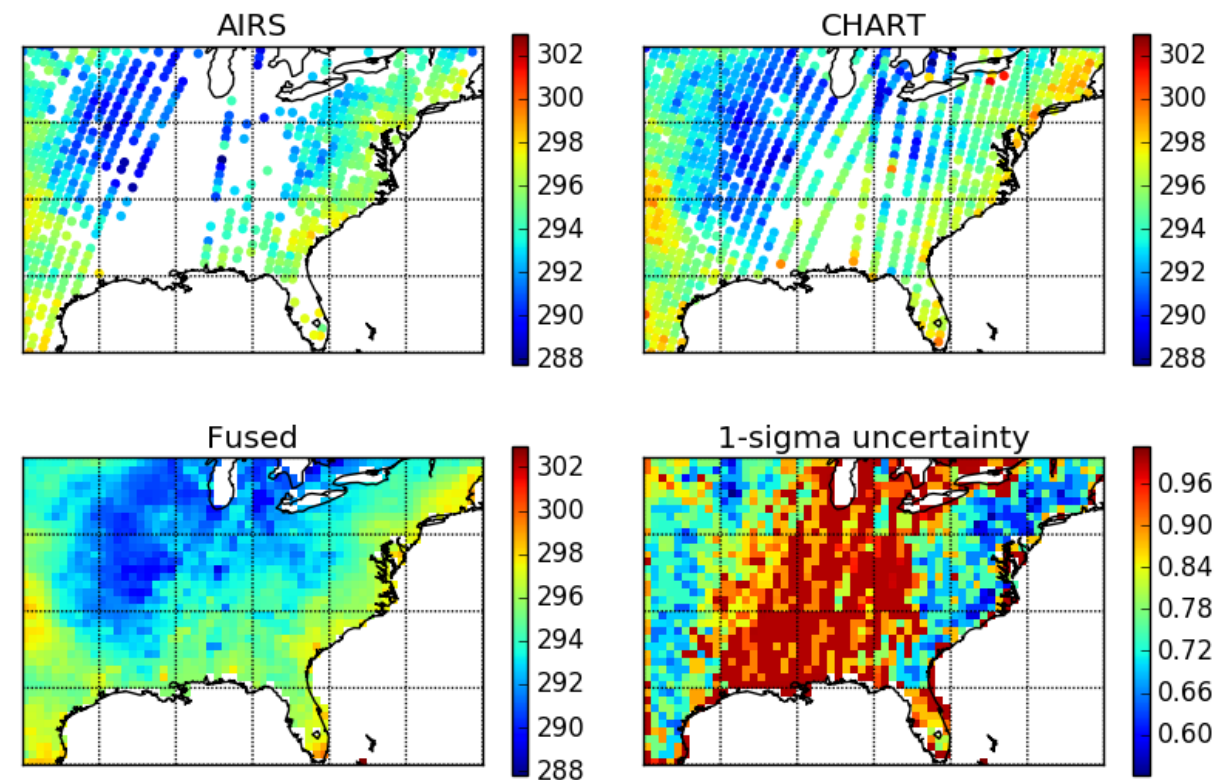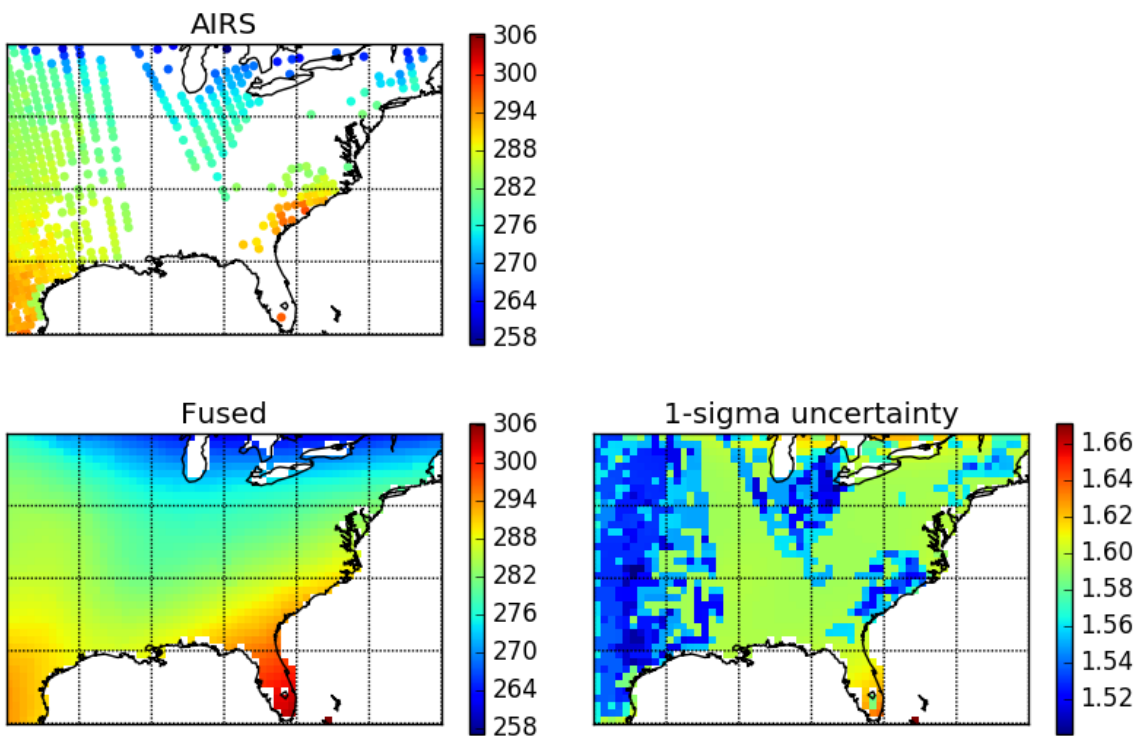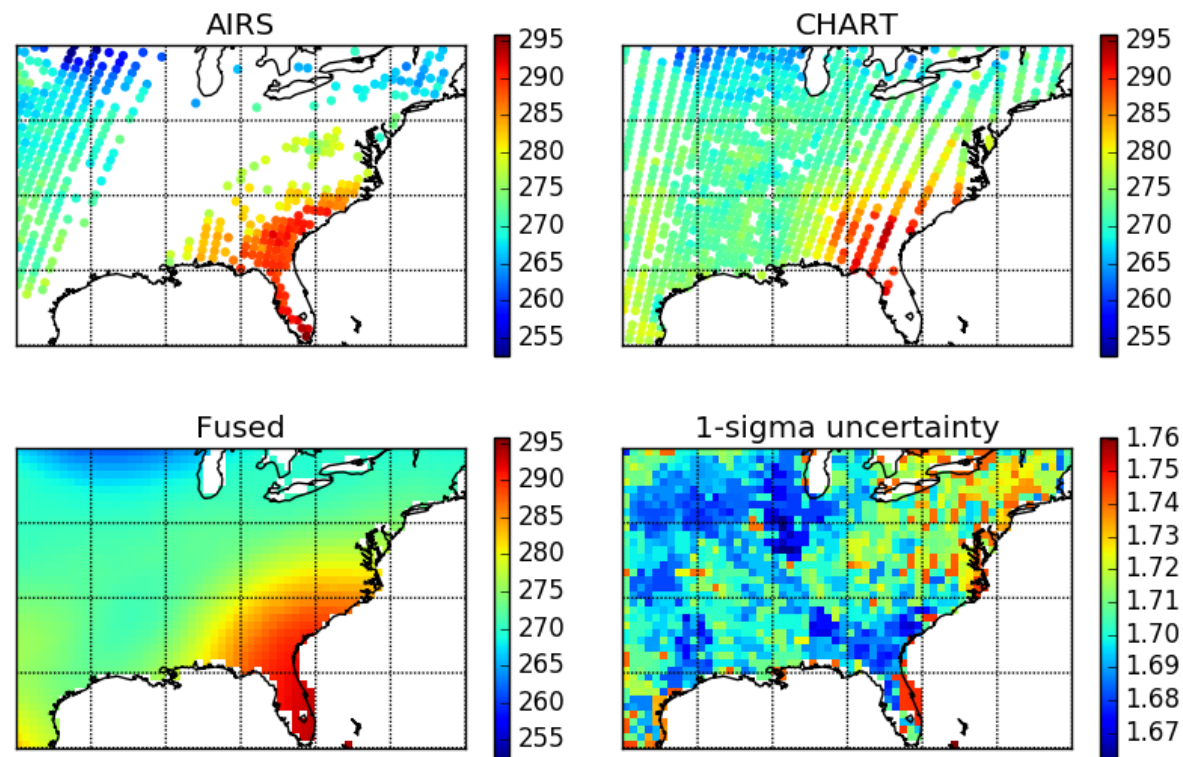
# Sample results



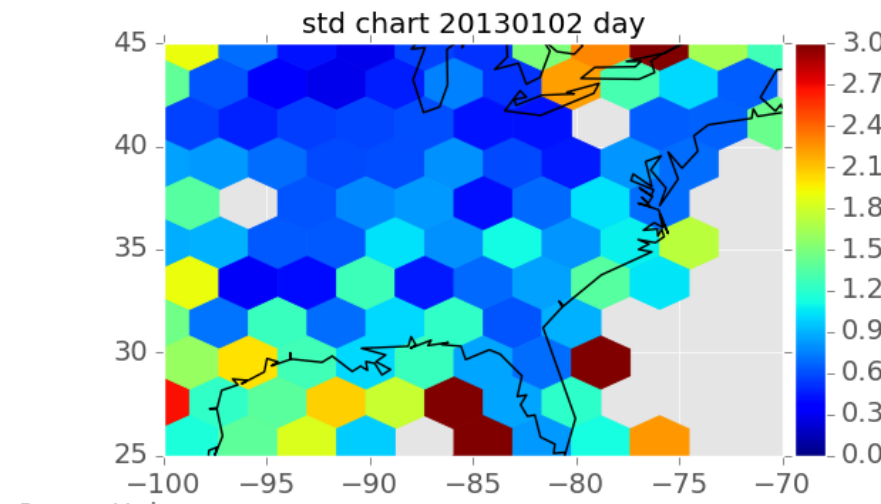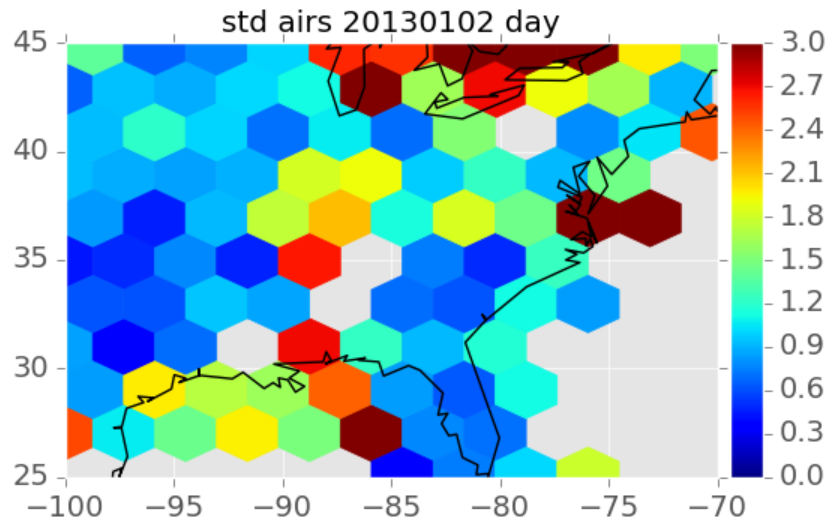20130705 day

20130705 night

# Sample results



20130117 day

AIRS

Fused          1-sigma uncertainty
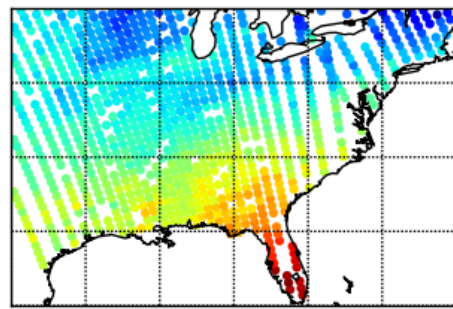
20130117 night

AIRS          CHART
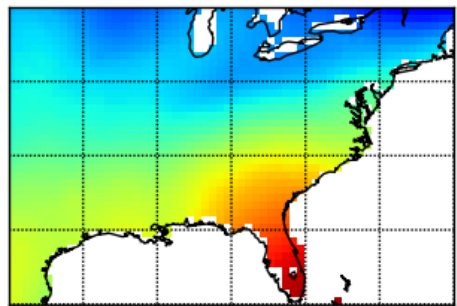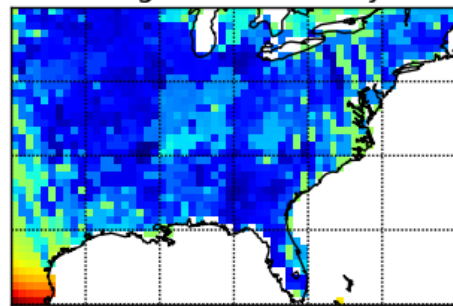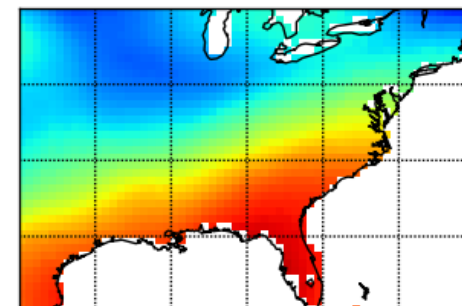
Fused          1-sigma uncertainty

# Sample biases and variances

3-day averages (day / night separate), 2° hex grid

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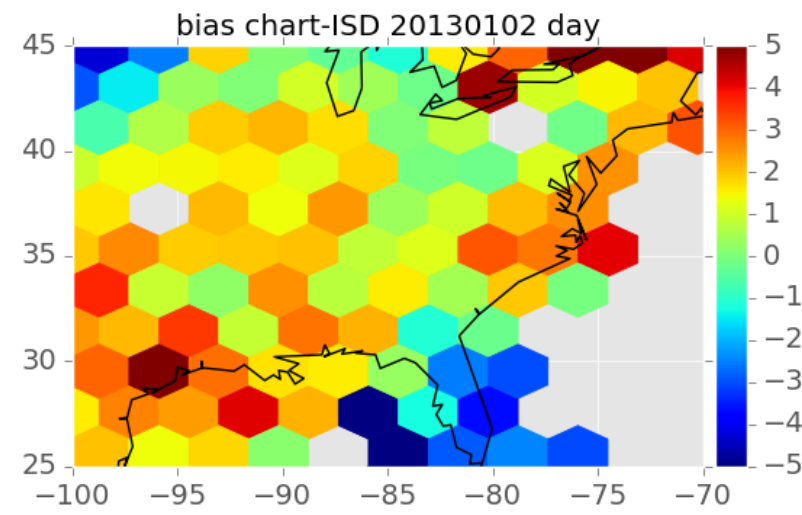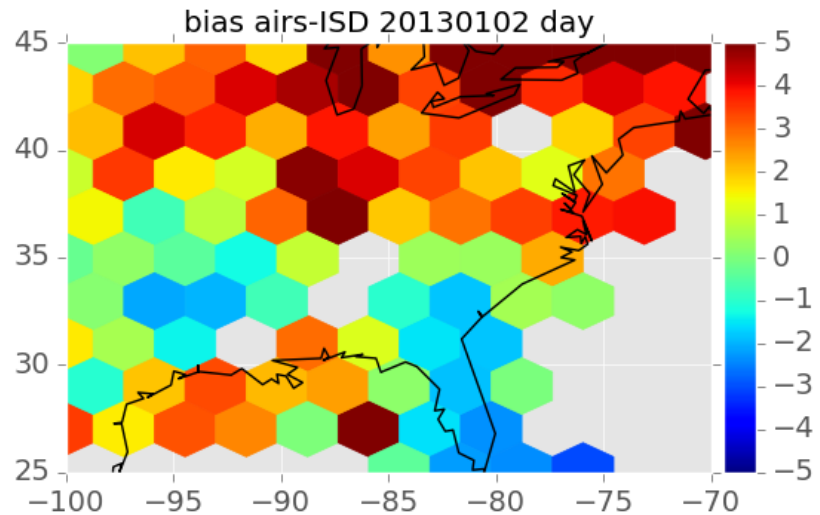
# Sample biases and variances

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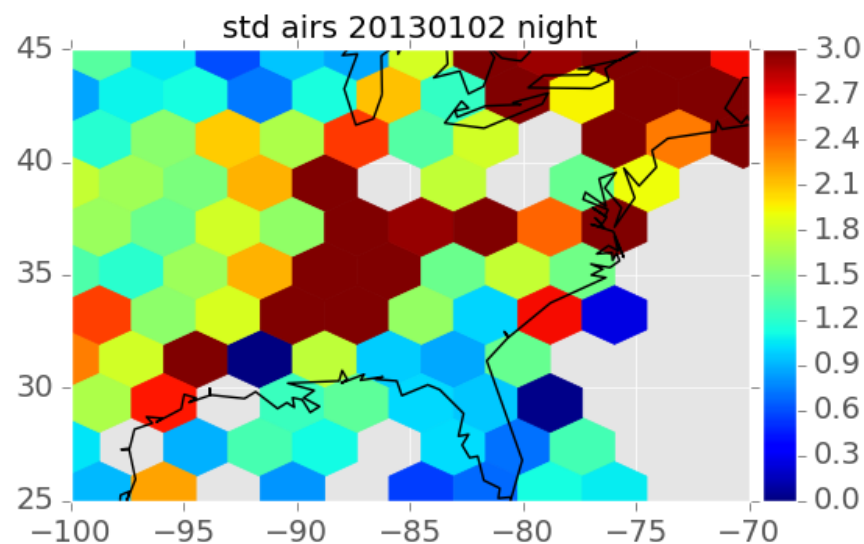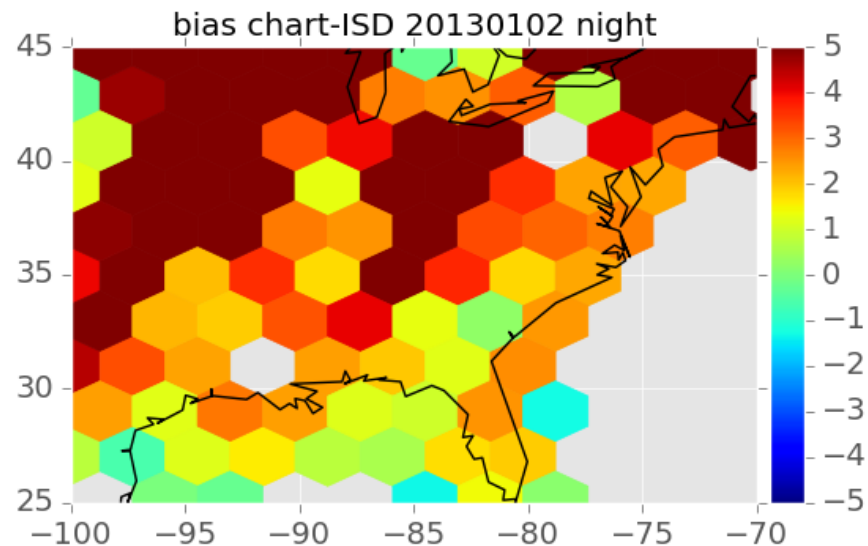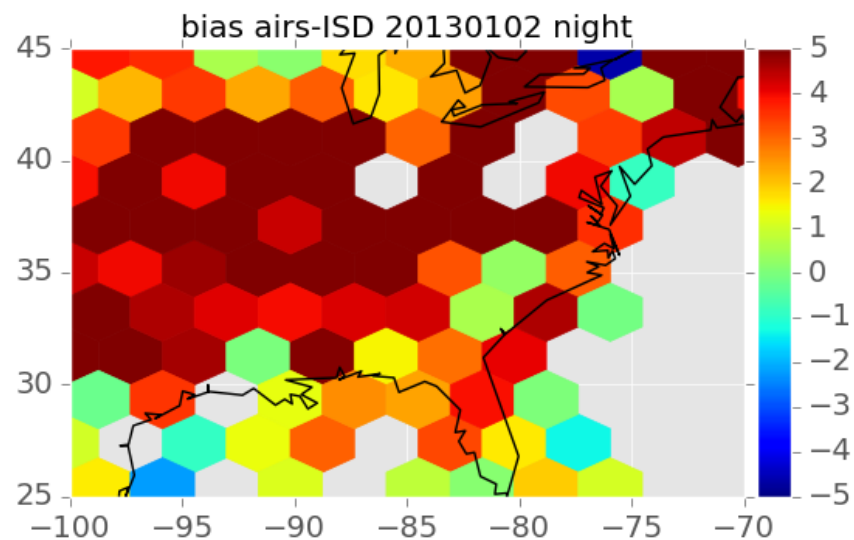
# Time window for bias estimate affects results

Mean values over all 8 months
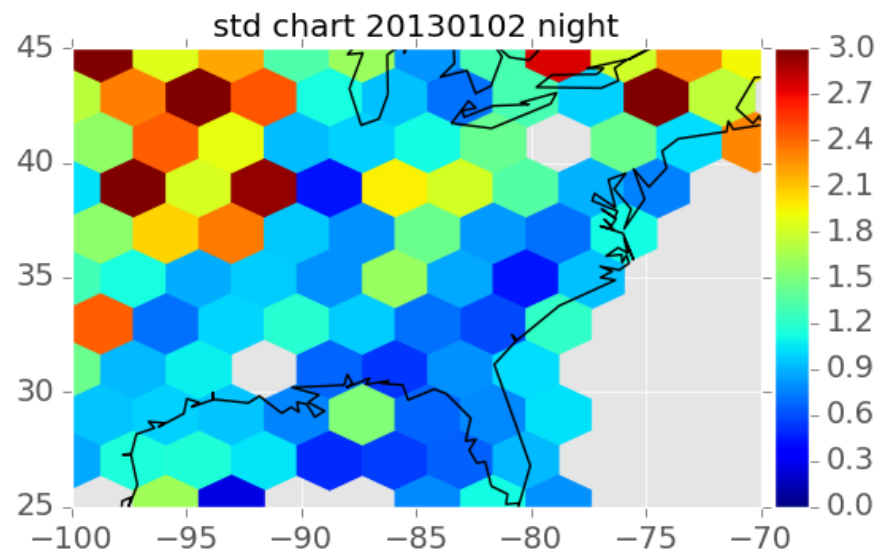
**monthly**

bias airs:     0.62
bias chart:    0.58
bias fused:    **0.14**

std airs:      2.55
std chart :    2.93
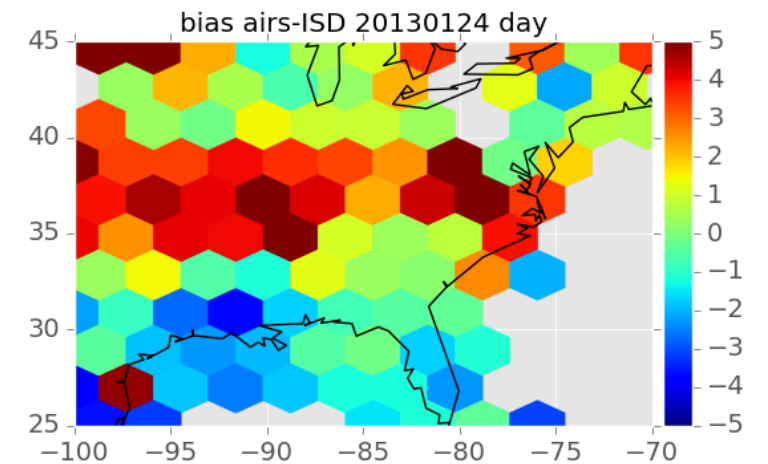std fused:     **2.56**

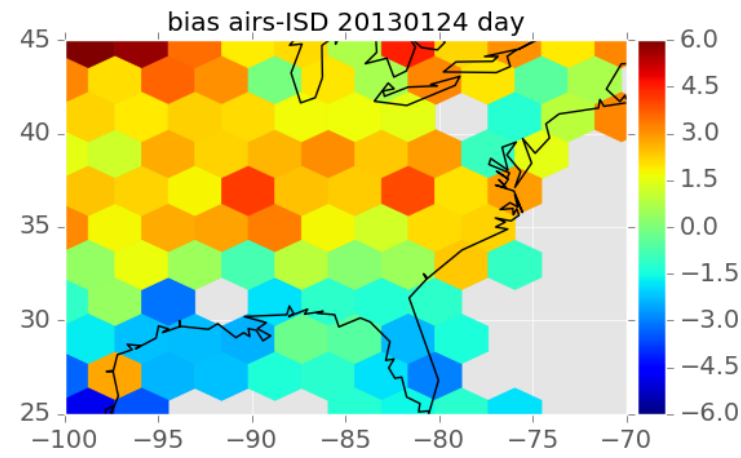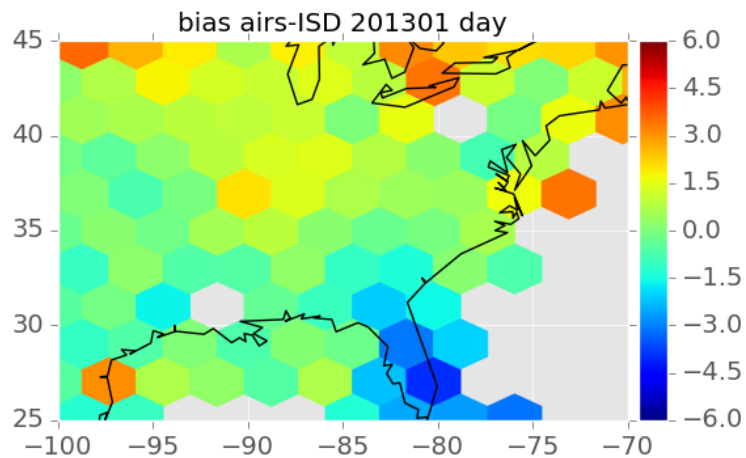**7-day**

bias airs:     0.63
bias chart :   0.57
bias fused:    **0.12**

std airs:      2.56
std chart :    2.94
std fused:     **2.45**

**3-day**

bias airs:     0.62
bias chart :   0.58
bias fused:    **0.13**

std airs:      2.56
std chart :    2.94
std fused:     **2.25**



bias airs-ISD 201301 day



bias airs-ISD 20130124 day



bias airs-ISD 20130124 day

# Conclusion

Basic NST AIRS+CHART fused product is ready (modulo finalizing validation):

1. Significantly reduces bias; also reduces variance.
2. Produces estimates even over data gaps (with higher uncertainties).
3. Produces uncertainty estimates.
4. Fusion calculation is fast.

Future work:

- Near surface humidity
- Compare to climatological products: HadCRUT4 (monthly), BEST (daily)
- Explore potential for UQ to improve bias, variance estimates
- Add satellites
- Because ISD is global, it would be possible to do global land analysis